Appendix 3:
Rules and Assumptions to be used in Testing the models and Use of fieldwork (Model 4)

Rules to be used in Testing the Models

Data Model 1: Adjusted Method Model

- Section A - Damage from Cultivation
- Section B - Drainage and Soil Permeability Measures
- Section C - Deeper Cultivation Through Soil Loss in Harvesting
- Section D - Water Erosion *(When annual rainfall is '<800mm' use bracketed answer)*
- Section E - Wind Erosion

For the results use the formulas below:

- *Section I - A + B*
- *Section II - D + E (When C is 'extremely likely' use bracketed answer)*
- *Section III - I + II*

Data Model 2: Scoring Method Model

- Section A - Buffer Zones
- Section B - Soils
- Section C - Slopes
- Section D - Cultivation Method
- Section E - Crops
- Section F - Compaction/Drainage

- Section I - Archaeological Survival
- Section II - Significance of Archaeology

For the results use the formulas below:

- *Add together A - F making sure you multiply the total with any serious/minimum weighting and work out confidence grade*
- *Add together I and II to find out weighting factor (adding any weighting) and work out confidence grade*
- *Finally multiply first score with weighting grade to get final score and work out final confidence grade*

Data Model 3: Flow Diagram Method Model

- Section A - Archaeological Significance
- Section B - Archaeological Survival
- Section C - Depth of Cultivation
- Section D - Slope
- Section E - Soil Type

For the results use the formulas below:

- *Follow the arrows and when 2 options then use your judgement from the above answers (always erring on the side of caution)*

Data Model 4: Final Method Model
Outline of the model

The model is divided into three main parts addressing:

Management factors:
- Buffer deposits (m)
- Cultivation method and depth (n)
- Crop regime (o)
- Compaction and drainage (p)

Erosion (site intrinsic) factors:
- Susceptibility of cultivation soil to erosion factors (slope vs soil type) (q)
- Susceptibility to deeper cultivation through soil movement through wind erosion (soil type) (r)
- Susceptibility to deeper cultivation through soil loss during harvesting (crop regime) (s)

Archaeological weighting:
- Archaeological survival and vulnerability (type of preservation) (t)
- Archaeological significance (u)

Application of the model

The final risk is expressed as a numerical figure scored out of a total of 100 which can be further broken down into individual scores for the three main categories (management, erosion and archaeology). The maximum scores obtainable in each category are related to the established overall importance for variables in terms of their contribution to risk. Management factors can score a maximum of 50, erosion factors a maximum of 30 and archaeological factors a maximum of 20. Each group of factors could theoretically be studied separately or as part of the overall risk value, allowing the identification of which category contributes most to the risk or whether the score is based on a more widespread contribution from all categories.

The model also uses a confidence scoring system, in order to gauge how confident the user of the model was in his/her conclusions based on the information available at the time of entering the data. This system uses the basic scoring system of A, B and C, with A representing a high degree of confidence placed on the data. Sites with a low confidence grading can be identified as requiring further field or background investigations to increase the confidence and accuracy of the model.

For the final risk score use the formulas below:
- Add together m - p making sure you multiply the total with any serious/minimum weighting and work out the confidence grade (=X)
- Add together q - s making sure you multiply the total with any serious/minimum weighting and work out the confidence grade (=Y)
- Add together t - u making sure you multiply the total with the final weighting and work out the confidence grade (=Z)
- Add together all of the overall scores for the three main sections (X+Y+Z) to produce the final risk score (scored out of 100)
- Use the confidence rating to assess whether further information is needed, eg through fieldwork.

The scoring system used for the model:

- 0-30 = Minimal risk
- 30-40 = Low risk
- 40-50 = Moderate risk
- 50-59 = High risk
- 60+ = Serious risk

Sites scoring 40 or over will need to have mitigation and management options considered in order to reduce this risk, discussed below.

Where a site displays differences in any of the variables discussed above, several model pro-forma sheets will have to be filled in for the same site. If fieldwork is undertaken these different areas will need to be targeted by test pits and the models revised in the light of these results. For example, where the site lies on a slope, a model pro-forma will need to be filled in for the top, middle and bottom of the slope. Where a site is split into several fields, each with a different type of cultivation or crop, then two model sheets will need to be filled in. Once all the models are filled in for each of the different variables tested, decisions on overall risk management for the whole site can be made. It may be that the top of the slope is at high risk and the base of the slope at low risk. Management solutions applied may be that the bottom of the slope remains in normal cultivation but the top of the slope is subject to restricted cultivation depth or other (see section 6).

Assumptions to be used in Testing Models 1-3

Testing Variables Before and After Fieldwork
Within each site certain variables are being tested to see whether these affect the impact of cultivation over the site in general. Presence of slopes and earthworks as well as differing soils and geology are all being targeted to establish how they change the level of risk, through cultivation, to the monument. Each variable is targeted by test pitting as part of the fieldwork process and therefore the models will be tied to these test pits in order to quantify levels of damage to the monument through cultivation.

For the first stage of risk models, before fieldwork commences, only slope, soils and presence of earthworks can be reckoned to affect the models. This is because, although there may be differing geology, we do not know how this will affect the soils covering the site until the fieldwork information is recovered. Therefore for sites with a uniform geology or differing geology only one model will be filled in per site before fieldwork commences, with all the differing variables being tested by each model after fieldwork. However for the presence of slopes and earthworks we can calculate how they may affect the impact of cultivation on the archaeology and so each variable will be tested with the models before fieldwork commences as listed below.

Presence of Slopes - Top, middle and bottom of the slope

- For the pre-fieldwork stage the bottoms of the slopes are assumed to have buffer zones present, these should be scored as being at slightly less risk than otherwise suggested by the farmers estimation of plough depths
- For the post-fieldwork stage buffer zones are only identified where they have been recorded within the fieldwork. This may be in stark contrast to the locations assumed in the pre-fieldwork stage.

Presence of Earthworks - Their presence will be analysed within the existing risk assessment models as indicated on the Ordnance Survey map.

- For Model 1 the buffer zone will always be 'None/Earthwork' when earthworks are present.
- For Model 2 the buffer zone and archaeological vulnerability will be serious risk if an earthwork is present.

Differing Soils – The location of each different soil type will be identified using the soil and geological maps, and each model filled in using these data.

- The pre-fieldwork soil identification will be based upon information on soil and geological maps.
- The post-fieldwork soil identification will be based on the actual field data.

Archaeological Significance

Model 2 (Section I) Model 3 (Section A)

- Assume that all Scheduled Monuments are of very high archaeological significance
- Assume that all non-scheduled sites selected by the SMR officers are high to moderate significance, unless evidence suggests otherwise

Archaeological Survival

Model 2 (Section II), Model 3 (Section B)

- Assume that most of the sites will be 'Medium to Uncertain' or 'Medium or High Hazard' except when earthworks or structural remains are apparent then it will be 'Well Preserved' or 'Serious Hazard'. If there is any evidence from the farmer of complex stratigraphy through previous fieldwork on his land or the site is deemed to be a Roman villa or fort then this would also be placed under 'Well Preserved' or 'Serious Hazard'.
- If it is a barrow or cemetery then all sites will be placed into 'Well Preserved' or 'High/Serious Hazard' because there might be shallow burial remains.
- All sites will score a C for Model 2 at the pre-fieldwork stage as the present condition of most of the sites are unknown.

Buffer zones

Model 1 (Section A), Model 2 (Section A), Model 3 (Section C)

- For Model 1 buffer zones are split into, highly likely (where there is no buffer or visible earthworks), likely (buffer of 0.01-0.05m), possible (buffer of 0.06-0.1m), unlikely (buffer of 0.11-0.2m) and highly unlikely (buffer greater than 0.2m).
- For Model 2 buffer zones are split into new ploughing, interface of archaeology, shallow buffer, 0.1-0.2m (where cultivation has taken place below 0.13m consistently), moderate buffer 0.2-0.75m and deeply buried >0.75m.
- For Model 3 buffer zones are split into new damage, no/limited buffer (cultivation practices of 0.13m and above), moderate buffer (cultivation practices of <0.13m), deeply buried (c. 0.2-0.75m).

Pre-fieldwork assumptions on buffer deposits:

- When defining the buffer zones (a) compare past cultivation with current plough depths from information obtained from interview and fill in accordingly - i.e. if ploughed to 0.3m in the past but now only ploughing at 0.1m then there will be a 0.2m buffer. b) However, it is likely that some farmers have been following the same regime over last 10 years, whether at 0.23m or 0.1m - if this is the case then it will have to be scored as present cultivation likely to be at interface, where clearly in the case of 0.1m there is in

fact likely to be a buffer. Therefore in these cases the assumption here is that the site was at one time ploughed to normal plough depth allowed on a Scheduled Monument (say 0.23m): so if now ploughed to 0.1m this would score as having a shallow (0.1-0.2) buffer). Where current cultivation depth is less than 0.2m and there is no or little difference between current cultivation depth and that carried out over the last 10 years then, take the current cultivation depth (x) from 0.2m (y) which gives you a predicted buffer (z). The same principle applies to Model 3 - Moderate buffer.

Comparisons

Model 1	Model 2	Model 3
0.01-0.05m	No buffer	No buffer
0.06-0.1m	Interface (high risk) or shallow (moderate risk) if 0.1m	No buffer unless 0.1 then moderate buffer
>0.11-0.2m	Shallow (moderate risk)	Moderate buffer
>0.2m.	0.2-0.75m is moderate (low risk)	Deeply buried
>0.25m	>0.75m (minimal risk) depending on depth	Deeply buried

Slope and Topography

- Model 1 (Section D), Model 2 (Section C), Model 3 (Section D)

- Slopes will be split into steep (>7°), moderate (7°-3°), shallow (3°-2°) and level/flat ground (<2°) for model 1
- Slopes will be split into steep (>7°)/ top of slope, moderate and shallow (7°-2°)/ middle of slope and flat ground/ bottom of slope for model 2 and 3. (Flat ground can also classify anywhere where soil would build up e.g. fencelines etc.)

Soil Type

- Model 1 (Section B, E, F), 2 (Section B) and 3 (Section E)

- For model 1 just follow the charts for the soil-types using the soil survey description for each site, except for the following cases.
    - In Section F, where the soil type is a loam, and therefore not categorised within the table, place it under '**silts**', unless it is a sandy or clayey loam in which case they will go under '**sands**' and '**clays**' respectively.
    - Where soils are a silty loam over clayey soils then use the description '**silty clay loam**'.
- For models 2, and 3 if soils are light and subject to rapid erosion (e.g. erosion is described in the soil survey description) or are heavy soils that need deep cultivation and extensive drainage then they will score high/poor. If a soil needs very little pan-busting and/or drainage like loamy soils, then it should be scored medium.

Cultivation Method and Depth

- Model 2 (Section D)

- Regular deep ploughing = anything over 0.25m (over 9.8 inches)
- Normal Ploughing/chisel ploughing (equivalent to inversion using discs of plough a) = 0.20m - 0.25m (7.8 -9.8 inches)
- Shallow ploughing (equivalent to inversion using discs of plough b) = 0.10-0.20m (4 - 7.8 inches)
- Continuous direct drilling (i.e. non-inversion - tines or direct drilling (or minimum tillage operations using discs where depth no deeper than 0.10m (4 inches)

- Therefore for model 2 there are 5 categories: new deeper cultivation is serious, regular deep ploughing (>0.25m), stone cleaning etc is high, standard inversion methods (0.2-0.25m) is medium, shallow inversion methods (0.1-0.2m) is low, direct drilling or minimum tillage (<0.1m) is minimum.

Compaction and Drainage

- Model 1 (section B), Model 2 (Section F)

- When looking at crop types for drainage and soil enhancement measures discuss the current crop for the field unless there is a rotation evident. If this is the case then discuss either the crop with the highest category rating (from high to low) or, if they are all in the same category, the main crop within the rotation. Conversely if the site is going into a management agreement or long-term ley then score the site on this as opposed to the highest scoring crop.
- In model 2 where Section F discusses subsoiling this has been changed to include pan-busting also. NB. All of the answers will be based on past cultivation methods unless it is known for certain that these practices no longer take place (e.g. when the land has changed ownership etc).

Model 2 Risk

In order to compare and contrast the models it was necessary to develop a conversion system for model 2 in order to give practical meaning to the risk scores. Two different scoring systems needed to be developed for model 2 in order that the non-scheduled sites risk scores were not too undervalued because of the archaeological weighting skewing the data.

Risk Level	Scheduled risk score	Non-scheduled score
Serious Risk	+39	+21
High Risk	30-38	16-20
Moderate Risk	20-29	11-15
Low Risk	10-19	6-10
Minimal Risk	0-9	0-5

Assumptions to be used in Testing Model 4

Assumptions to be used in testing Model 4

The following guidelines ensure consistency in the use of the model. Some of the assumptions are necessary to ensure that the model provides an accurate assessment of risk, based on the COSMIC results. Other assumptions are to be used as a guide where fieldwork is not to be undertaken, or where the decision on whether to apply fieldwork depends on the results of the model. The model itself also provides guidance on the assumptions to make.

Buffer zones:

- without fieldwork - Unless there is good evidence to suggest buffer zones are present, score site ‘high’ (present cultivation at interface with archaeology). Originally the models were scored by comparing past cultivation with current plough depths using information

obtained from the farmer. However, it was found that farmers often underestimated cultivation depth, causing the models to underestimate the risk to the site
- without fieldwork - If the site is on a slope then there may be a buffer at the base of the slope and thin soils at the top of, and on the slope. Decisions on this should be made in conjunction with the 'susceptibility to erosion' results below. ie if the slopes and soils present lead to a 'serious' or 'high' risk of erosion, then a buffer can be inferred at the base of the slope and a thinning of the soil at the top of, and on the slope.
- score 'serious' if an earthwork is present.
- without fieldwork - Take into account any evidence given by farmers for fresh damage ('serious' risk) on the site
- with fieldwork - Depth of buffer zones and any areas of fresh disturbance will be obvious

Cultivation Method and Depth and Cropping Regime:

- Farmers will be able to provide this information. When looking at crop types apply the current crop for the field unless there is evidence for crop rotation. If rotation is practised, use either the crop with the highest category rating (from high to low) within the rotation or, if they are all in the same category, the main crop within the rotation. Conversely if the site is going into a management agreement or long-term ley then score the site on this, as opposed to the highest scoring crop.

Compaction and Drainage:

- The farmer should be able to advise on this. The risk levels associated with the frequency of sub-soiling and pan-busting are fully explained in the model.

Slope and Topography:

- Slopes will be split into steep (>7°) and top of slope ('serious'), moderate (7°-3°) middle of slope ('high'), shallow (2-3°) middle of slope ('medium'), and flat ground/ bottom of slope ('minimal'). Flat ground can also classify anywhere where soil would build up e.g. fencelines etc.

Differing Soils:

- without fieldwork - The farmer is likely to know the soil type on the field. If not test the soil and judge for yourself whether it is clay, silt, sandy soil etc. A soil map could be used but these are not always accurate enough for individual sites. It is possible that several soil types may be present within a site. Again the farmer may know.
- With fieldwork - soils can be assessed in the excavation of the test pits.

Presence of earthworks - will be obvious when the site is visited

Archaeological Significance:

- assume that all Scheduled Monuments are of very high archaeological significance.
- assume that all non-scheduled sites are of regional or county significance, unless evidence suggests otherwise.

Archaeological Survival and Vulnerability:

- without fieldwork - unless there is evidence to suggest otherwise all sites should score a C as the vulnerability of many sites will be unknown.
- without fieldwork - as a default, unless the evidence suggests otherwise (ie where little is known) assume that most of the sites will be 'medium' or 'high' risk except when earthworks or structural remains are apparent then it will be 'serious' risk.
- if previous archaeological work has suggested complex stratigraphy survives, or the site falls under any of the categories defined as at 'serious' risk in the model, then score 'serious' and weight accordingly.
- barrows or cemeteries will be classed as at 'serious' risk because there might be shallow burial remains.

Use of fieldwork - Model 4

Necessity of fieldwork

Once the level of risk has been established and the degree of certainty estimated (ie A-C, see below) a decision can be made as to whether fieldwork is needed to further clarify the level of risk. It may be that up to 20% of sites will need fieldwork, either to clarify the level of risk or in the event of a farmer challenging the conclusions of the risk assessment (for example, he may claim that all archaeological deposits have been destroyed by 19th century steam ploughing). The farmer's potential hostility to any management change will have been gauged in the farm interview stage.

Methodology for fieldwork

Fieldwork will consist of a walkover, the excavation of test pits, possibly augmented by auger survey. The number of test pits required will vary from site to site and field to field depending on the type and number of variables present. Where numerous variables exist within a field they should all be tested with test pits. For example, where the site lies on a sloping field, a sequence of 3 test pits should be excavated testing the top, bottom and middle of the slope. All sites/fields should have at least two test pits.

The variables which should be tested using test pits include:

- **Multiple Crops and Cultivation Systems** - Where the archaeological site covers more than one field, both the historical and current cropping regimes and cultivation systems should be analysed for variation. When this occurs each monument should be split into its separate fields reflecting the cropping /cultivation differences and tested for the variables noted below.
- **Change in Slope** - Slopes are categorised as one of three types: steep (greater than 7°), moderate (3-7°) and gentle (2-3°) (using contour data on the OS[1] 1:10,000 base map or by eye). These should be targeted separately and split into three zones, top, middle and bottom of the slope, with at least one test pit on each, unless the area of the site on the slope is not large enough. In this case only two test pits, one at the top and one at the bottom, should be used.
- **Presence of Earthworks** - All earthworks should be targeted with test pits. Each earthwork should have a test pit at the top and bottom of each earthwork, while larger sites should also have a test pit in the middle of the slope. Those with a series of earthwork platforms should have each level tested.
- **Soil Texture** - Different ploughsoil types should be tested with a test pit.

Fieldwork should start with an initial walkover survey to look for evidence of recent disturbance in the form of fresh and friable artefacts or recent subsoil on the field surface. Any such remains should be recorded on the fieldwork pro-forma and the position of the material recorded using a hand-held GPS. Ideally the walkover would be carried out just after cultivation.

Each test pit should be located using a hand-held GPS. This is considered of sufficient accuracy (minimum *c* 10 m), as the intention is to provide a characterisation of the ploughsoil, rather than of the archaeological site itself. Ploughsoil depths and soil matrix should be recorded through hand-dug small test pits, *c* 0.3 m square, excavated down to the top of the subsoil or the top of the uppermost identifiable archaeological deposit. The nature of the subsoil/archaeological deposit at the base of the test-pit should also be recorded. Training

[1] Steep >7° (5m contours<40m apart); Moderate 7-3° (5m contours 40-90m apart);
Gentle 3-2° (5m contours 90-140m apart); Level ground <2° (5m contours >140m apart)

may be needed to enable fieldworkers to distinguish between old and current ploughsoils. All test pits should be backfilled immediately after recording.

A program of augering was undertaken alongside test pit excavations on a number of COSMIC sites so that the results of the two methodologies could be compared. The results revealed that test pits are the most accurate method to assess differences in soils. However, in areas of deeper deposits, eg alluvium or colluvium, the auger proved useful for investigating deeper deposits with greater efficiency, after the stratigraphic sequence had been first recorded in test pits.

It will be worth making it very clear to farmers that, if fieldwork is proposed, the test pits will be hand-dug, that no machinery will be used and that only one person would carry out this work.